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THE PLANT DISEASE SURVEY

DIVISION OF MYCOLOGY AND DISEASE SURVEY

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# AN ATTEMPTED ANALYSIS OF THE ECONOMIC EFFECTS OF CRANBERRY DISEASES

Neil E. Stevens

## Introduction

Plant pathologists are frequently asked for specific figures as to the economic losses due to plant diseases in general or to some particular disease. Such requests apparently come from those who have little idea of the complex problems involved either in the field of plant pathology or of economics. On the other hand, it must be admitted that pathologists as a group have frequently made themselves liable to such inquiries by somewhat positive statements regarding the monetary significance of certain plant diseases. Moreover, the fact that definite conclusions or even general agreement cannot now be reached is certainly no excuse for refusing to make a serious attack on the problem.[1]

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[1]Although the writer is solely responsible for the conclusions and opinions in this paper, he is glad to acknowledge assistance received in

The publication in 1934 by a group of investigators of a discussion of some of the difficulties in appraising the economic aspects of changing volume and quality of products as illustrated by certain crops of peaches, prunes, oranges, and grapes[2] has encouraged the writer to attempt an analysis of the economic effects of some cranberry diseases. While the results are far from satisfactory or conclusive, a discussion of the considerations involved may have interest for other pathologists faced with similar but more complex problems.

The cultivated cranberry appears to be particularly adapted to a study of this sort. Cranberry growing is a very limited, highly specialized industry, not affected by rapid changes in acreage and ownership. The cranberry is considered a luxury or at least not a prime necessity of life and this prevents the extreme rises in price conceivable in great food crops under conditions of critical shortage. Moreover, in spite of opinion to the contrary by some actively engaged in cranberry marketing, the demand for cranberries seems to be very little affected by competitive products.[3] The marketing season is limited, being largely confined to the period from September to February or March. The selling of cr nberries is highly organized, approximately two-thirds of the national crop being marketed through a single cooperative organization. Regarding crop volume, quality, and selling prices, relatively full information is available over a long period. The problem is further simplified by the fact that whole classes of diseases such as the leaf spots, blossom blights, and root troubles, common in other crops, the losses from which cannot even be approximately guessed, are apparently of relatively slight importance in cranberries. In passing it may be pointed out that one reason more significant figures regarding the losses due to these field diseases cannot be obtained lies in the fact that there is no way of knowing the absolute maximum yield of a crop, i.e., what the plants would produce if no adverse conditions of any sort were encountered. For the purposes of the present study the diseases just mentioned are disregarded and attention is confined to the fruit rots and to false blossom.

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its preparation from various people consulted including the following: W. A. Taylor, M. B. Waite, Charles Brooks, and Carl Hartley, investigators of long experience and wide general knowledge regarding plant disease problems; C. L. Shear and H. F. Bain who have specialized for many years in the study of cranberry diseases; L. M. Rogers and C. L. Lewis, experienced cranberry growers; A. U. Chaney and C. M. Chaney, President and Treasurer, respectively, of the American Cranberry Exchange; F. F. Elliott and O. V. Wells, economists of the A.A.A; and Gustave Burmeister, of the Division of Statistical and Historical Research. Bureau of Agricultural Economics.

[2] Smith, H. S., et al. The efficacy and economic effects of Plant Quarantines in California. Calif. Agr. Exp. Sta. Bul. 553. 276 pp. July 1933.

[3] Bean, L. H. Factors affecting the yearly average price of cranberries. The Agricultural Situation 12(8): 17-18. Aug. 1, 1928.

## General Considerations

An appraisal of the effects of even so economically simple a group of diseases as cranberry fruit rots, actually involves the consideration of a number of factors the evaluation of some of which must be largely conjectural. Obviously, in dealing with economic losses due to disease the producer and consumer should be considered separately, even if their interests are in some respects identical.

The actual price or at least the relative unit prices in different years paid by consumers may be determined with a fair degree of accuracy. The value of the money paid out in terms of the general commodity price level may also be ascertained, but the real worth of the fruit to the consumer, that is, its value in terms of nourishment or pleasure, or both, is largely a matter of its quality. Yet both the quality of fruit and the relative actual value of different grades can at present not be measured but only estimated.

In dealing with economic effects of cranberry diseases on producers, it is necessary to consider first of all the unit and total prices obtained for crops of various sizes. These may readily be determined with fair accuracy, as may the value of the money received. Volume and quality reduction due to disease must both be estimated. The influence of quality on demand and this on price is believed by all competent observers to be important, but the amount of its effect can only be guessed. The probable price at which a crop would have sold in the absence of disease, with the concomitant increase in volume and improvement in quality is at best a matter of conjecture. Figures are not available regarding the relative costs of producing and handling large or small crops. Very little is known regarding effects of disease incidence on capital value of properties and almost nothing regarding the effect on the plants of very large or very small crops. Finally, the actual amount of disease is never determined but is merely estimated.

## Size of Cranberry Crop in Relation to Producer and Consumer

The facts on yield, price per barrel and total returns to growers for the past twenty years are given in Figures 42 and 43. Total production is given in terms of number of barrels of cranberries produced in Massachusetts, New Jersey (including Long Island, N. Y.) and Wisconsin, which is the only figure available over a long period, and for practical purposes represents the entire cranberry crop of the United States. The actual price to the consumer cannot be obtained and is represented here by the average price in dollars per barrel f.o.b. shipping points of all berries sold through the American Cranberry Exchange. The exchange sells approximately 60 per cent of the total crop and prices of berries sold outside are in general not very different. The retail price is, of course, somewhat higher but it follows the same general trend as the f.o.b price. As the cranberry barrel is a special legal unit containing

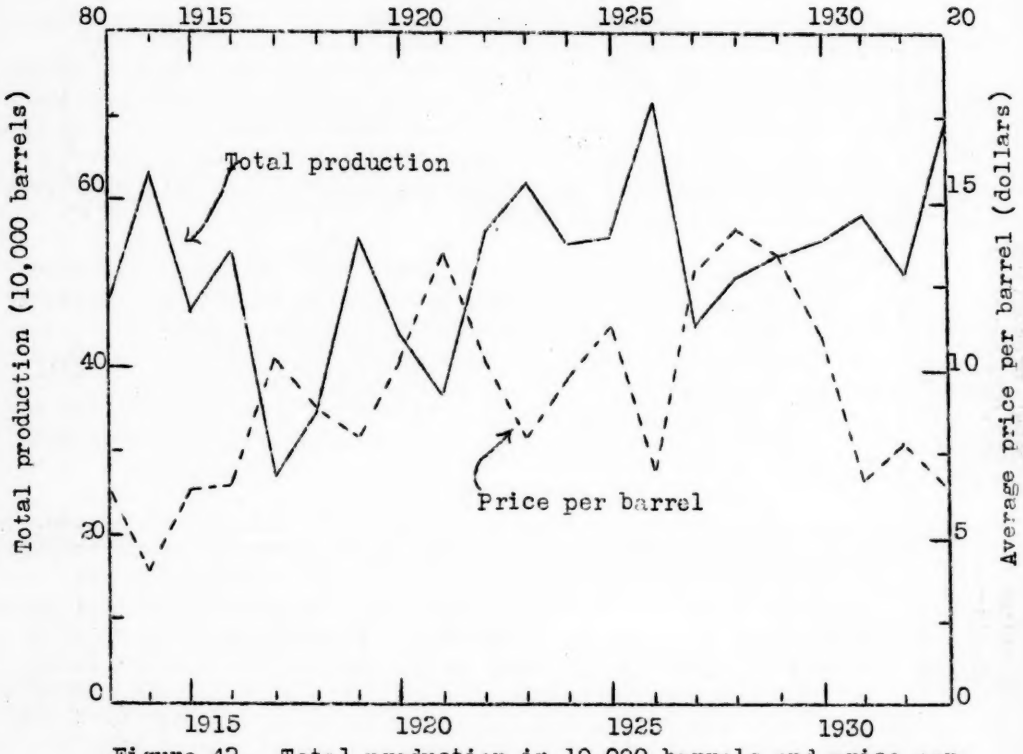


Figure 42. Total production in 10,000 barrels and price per barrel based on average F.O.B. price of all berries sold by the American Cranberry Exchange

approximately 100 pounds the curve may be read either in dollars per barrel or cents per pound. Total income to cranberry growers of Massachusetts, New Jersey, Long Island, and Wisconsin is based on total production in barrels multiplied by the average selling price.

A negative correlation between the size of crop and unit cost to consumer is obvious and has already been pointed out by Bean,(L. C., see footnote 3) in a short paper dealing with the years 1921-1929. The larger crops (see Fig. 42) have sold for lower unit prices than the smaller crops during the same period. Consumers, then, have obviously benefited from the larger crops provided the quality has been equal.

On the other hand, while it is apparent that in general a very large crop is worth less than a somewhat smaller one, the total returns to growers do not seem to the writer to have been unduly depressed by the larger crops. The highest returns to growers, over six million dollars, were received in 1925, 1927, 1928, 1929, and 1930, from crops of between four hundred sixty thousand and five hundred sixty thousand barrels. It should be noted,

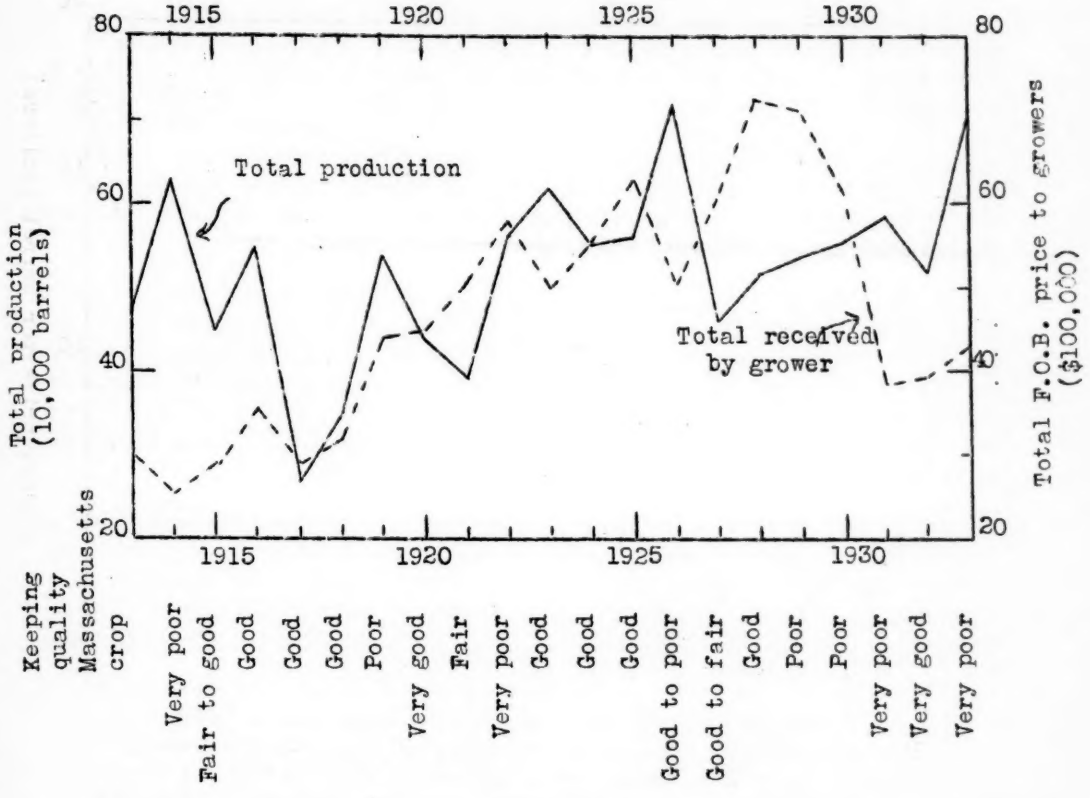


Figure 43. Total production of cranberries in 10,000 barrels, total F.O.B. price to growers in $100,000, and keeping quality of Massachusetts crop

however, that two of the largest crops of record, 1923 and 1926, brought approximately five million dollars, a figure apparently ample to maintain cranberry growing as a stable and adequately profitable industry. These facts suggest that at no time during the past twenty years, or for that matter in the history of the industry, has there been a crop so large as by its volume alone to depress the price received by growers sufficiently to "prevent the reasonably efficient grower" from receiving "a fair net income." The most probable exception to this is the large crop of 1914 which netted a low total return to growers. The 1914 crop was also characterized by extraordinarily poor keeping quality. The significance of this factor will be discussed in a later section.

In other words, the cranberry industry appears never to have suffered during the period under review from over-production, as such, even in the most limited sense of the word. Judging by the results of 1926 it would have been possible to have sold at any time during the twenties a seven hundred thousand barrel crop of sound cranberries at prices to consumers somewhat lower than the average of those

actually charged yet without material injury to the grower. In further explanation of the last statement it should be pointed out that there is no evidence from observation to indicate that the largest crops of cranberries so far obtained have caused any serious injury to the plants themselves. The disastrous effects which often follow bumper crops on tree fruits such as peaches are unknown in cranberries. Nor are harvesting costs unduly increased by very heavy production. While the total cost of harvesting a heavy crop of cranberries is larger, the whole operation is so much more economically carried out that the cost of harvesting is actually less, per unit of crop.

So large a proportion of the cost of storing cranberries is represented by the investment in store houses and equipment that here again the larger crop is actually handled at a smaller cost per unit. On the other hand, costs of packing and packages necessarily increase almost in proportion to the size of the crop. The cost of even the best packages used in cranberries has in recent years never represented more than 10 per cent of the f.o.b. selling price.

In all fairness and as an illustration of the impossibility of reaching any general agreement in a matter of this sort it should be pointed out that a quite different view is held by some observers. For example, Dr. A. W. Gilbert, Commissioner of Agriculture of Massachusetts, in addressing the Cape Cod Cranberry Growers Association, May 2, 1932, expressed the following opinion.

> "A 500,000 barrel crop on the average should bring not less than $10.00, generally considered a profitable price. Anything over 500,000 barrels depresses this price. A large crop lowers the price below the cost of production. In 1931 a crop of 651,000 barrels only brought $5.99 a barrel. If 100,000 barrels could have been taken off the market as whole berries, a profit could have been secured."

This generalization seems to the writer hardly warranted by the recent record in view of the fact that the crops of 1926 and 1929, both well over 500,000 barrels, were sold for an average price per barrel of $14.30 and $13.44 giving the largest total returns to growers ever received, and the still larger crop of 1930 netted almost $11.90 per barrel. Nor should the continued unfavorable general business conditions and the very poor quality of the 1931 crop be forgotten in connection with the low prices of that year.

Even a 700,000 barrel crop of cranberries represents only a little over a pint per capita for the United States, and cranberries from this country are regularly used to some extent in Canada. In spite of this low per capita consumption, over-production in the cranberry industry seems to have been prevented by factors other than disease. Among these may be mentioned the large investment necessary to going into the business and the importance of skilled management.

Preparing land for intensive cranberry culture always entails large expense. Such preparation usually involves the cost of constructing main ditches or canals for carrying water or large dikes for reservoirs; frequently involves the cost of pumping plants; and always involves extensive outlays for clearing land, leveling, sanding and planting, digging lateral ditches, and building bog dikes. The risks of cranberry growing are very large and under any but the most skillful management losses from frost and insects are apt to be so heavy as to lead to disaster.

If, on the one hand, very large crops of sound cranberries have not resulted in unduly low returns to growers it is also evident that very short crops such as 1917, 1918, and 1921 have not resulted in prices high enough to greatly raise the total returns. The cranberry is not a necessity of life and obviously the point at which buying will cease is soon reached. Moreover, far sighted sales management has usually succeeded in keeping the actual price during periods of shortage below what might have been obtained. As a result, if the period under review is considered as a whole, the price obtained per unit has so far offset the total volume of the crop that there is very little correlation between the size of crop and total returns to growers as a group. This is capable of easy mathematical demonstration.[4] When the deviations of the annual total crops and total returns to growers are plotted on their moving averages as an axis they fall on the same side of the 0 line 10 times and on opposite sides 8 times (Fig. 44). In this case, Pearson's Coefficient of Correlation is -.06.

It has been pointed out by several commentators that if only the period beginning in 1922 or 1923 is considered, there is a definite negative correlation between size of crop and the amount received by the grower. The possibility that this relation is inevitable and will continue to be operative should, of course, receive the serious consideration of anyone who attempts to discuss the economics of plant disease. The question is ably discussed from this point of view with reference to cranberries by Mr. Gustave Burmeister of the Bureau of Agricultural Economics in comments which I have been permitted to quote. With reference to the preceding paragraph, he says:

> "This statement is true if no adjustment is made in prices or total value of the crop for changes in demand conditions or the general price level. If an adjustment is made, however, there is a high correlation between the size of the crop and the total value. At least this appears to be true with farm prices and total farm value of cranberries during the period 1919 to 1933. This relation indicates that small crops return much more money to growers than large crops."

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[4] King, W. I. The Elements of Statistical Method. New York, 1912.

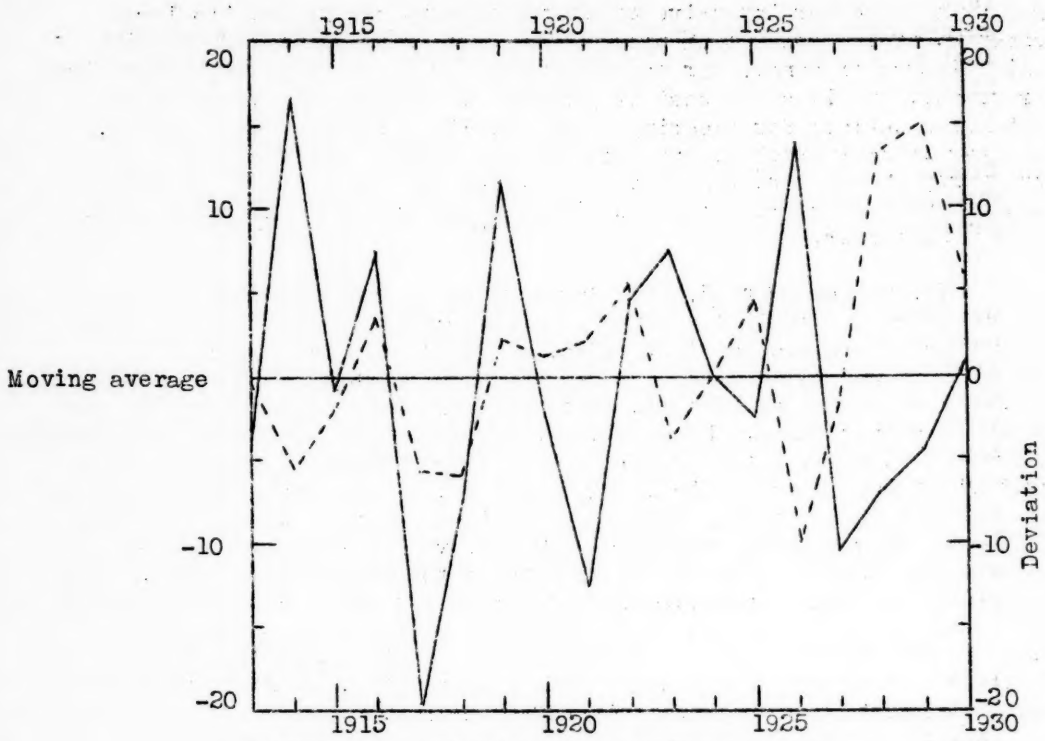


Figure 44. Deviation from moving average: _____ total cranberry crop, - - - total returns to growers

With reference to the entire problem, he says further:

"In general it appears that the author has failed to adequately allow for the influence of the two principal factors, the size of the cranberry crop and general demand conditions, affecting prices and total value of the cranberry crop and, therefore, has been misled in developing his conclusions as to the loss incurred from the ravages of cranberry diseases. It has been assumed that prices would not be unduly depressed by an increase in the size of the crop, but that a fair price would be received for the larger crop each year and that the total return would increase with the size of the crop. If this assumption is correct, then the losses of berries from disease is a loss to the growers.

"My analysis indicates that, since 1919 at least, the demand for cranberries in the United States has been very inelastic, that is, large crops have consistently brought lower prices and smaller total returns to growers than small crops, due allowance

being made for changes in general demand conditions. If this is true then it is certain that the growers as a whole have gained from the ravages of disease. The individual growers have lost to the extent that the damage from disease is greater in his particular bogs than the average for the entire industry.

"A study of the shape and slope of the demand curve derived from a correlation of crop-year average prices with annual production, general demand conditions (in this case industrial production) held constant at the 1923-25 level, indicates that a crop of 400,000 barrels would return growers approximately $8,370,000; 500,000 barrels, $6,500,000; 600,000 barrels, $5,700,000; and 700,000 barrels, $5,075,000. If cranberry growers have lost an average of 120,000 barrels of cranberries per year from rot and about 35,000 from false blossom, it is conceivable that they, as a group, have gained many millions of dollars in increased returns for the smaller crops. It does not seem probable that the extra cost for grading out the rotten fruit has offset these large gains. A few individual growers may have lost money, but the industry as a whole has gained. It is not unlikely, also, that the additional supply of marketable fruit would have depressed cranberry prices to such an extent that many of the inefficient growers would have been forced out of business.

"If we assume that the growers have gained, consumers have lost from the ravages of cranberry diseases. It is inconceivable that both consumers and growers as separate groups could gain from the saving of more cranberries for market when the demand curve is so inelastic."

That the writer is unable to accept these conclusions in their entirety with specific reference to cranberries has already been indicated. There must obviously be a point below which further reduction in the size of the crop could not possibly increase the returns to the producers.

Fifteen years of intimate contact with the cranberry industry have convinced the writer that both consumers and growers as separate groups do on the whole gain from sound crops of cranberries and lose from badly-diseased ones. The growers gain through having a more economically handled and saleable lot of fruit and the consumers gain in getting more value for their money, which is surely as important a consideration from their point of view as a lower unit price. This will be discussed further under the heading "Quality." In any case, it should be noted that the point of view represented by the quotations from Gilbert and Burmeister refer only to producers as a group. It is apparently admitted by all that any increase in the size of the crop which may reasonably be expected under present conditions will result in direct advantage to the consumer. The interests of consumers have too frequently been overlooked in discussing the economics of plant disease control.[5]

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[5] Stevens, Neil E. Plant pathology and the consumer. Sci. Monthly 37: 325-329. Oct. 1933.

## False Blossom

Students of cranberry problems are now agreed that false blossom is the most serious disease known on cranberries. It is an insect-borne virus disease inducing malformations which result in the production of sterile blossoms and sometimes in the death of the plants. As the literature on the disease and its history is fairly complete attention will be directed here merely to its economic effects. Since false blossom has very little if any effect on the quality of the few berries produced on diseased plants, the discussion of its economic effects is not complicated by this factor.

The graphs, Figure 45, give the production of cranberries during the past twenty years for the chief cranberry producing areas and for the country as a whole (in thousands of barrels), smoothed by 5-year moving averages to bring out general trends. The outstanding features of these curves are, first, a drop in total production during the period 1914 to 1919 in Massachusetts so severe as to affect the general average, second, a gradual general increase in crops until 1924, and third, beginning in 1925 a decline in New Jersey yields so marked and steady as to slow down and finally apparently stop the increase in the crop as a whole.

The drop in production from 1914 to 1919 seems to have been largely a result of enforced partial neglect of the bogs due to scarcity of labor and high wages during the war. The drop is most marked in Massachusetts where the bogs are given the most intensive care. Wilcox, who first plotted production curves of this type for New Jersey and has studied the situation there carefully for many years, attributed the decline in production in that State since 1924 almost solely to the inroads of false blossom, citing as proof, among other points, the fact that the decline has been greatest in the varieties known to be most susceptible to this disease.

The cash loss to New Jersey on account of false blossom during a period of generally excellent demand and price for cranberries and during which both Massachusetts and Wisconsin were increasing yields can readily be computed from the figures given in the various graphs. The total loss to the State during the ten year period of at least 350 thousand barrels of cranberries, means a loss in income to New Jersey due to cranberry false blossom of well over two million dollars, even if they are valued at so ridiculously low a price as six dollars a barrel f.o.b. To this must be added serious depreciation of capital values (wholly aside from general economic changes) due to decreased yield and increased cost of operation on some diseased bogs and abandonment of whole sections on others. This depreciation is certainly as great in proportion as the loss in yield during the ten-year period, or about 25 per cent. Since the disease is not yet under control depreciation is still on the increase. Figuring that in the period 1923-1926, New Jersey had ten thousand acres of cranberry bog worth at least $400

Thousands of barrels

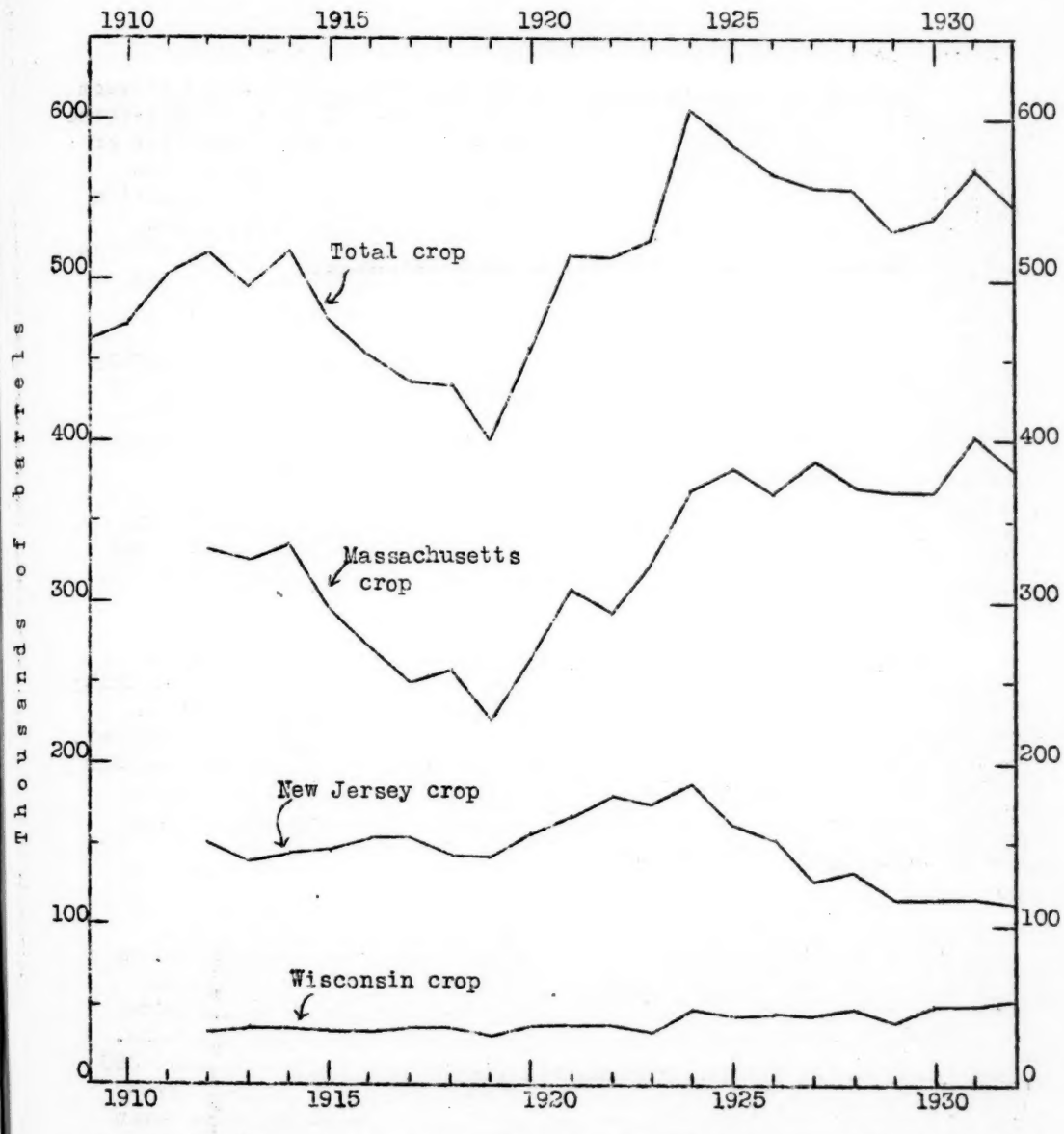


Figure 45. Five-year moving averages of cranberry crops (thousands of barrels)

per acre the capital value has depreciated well over a million dollars.

The case as regards Massachusetts and Wisconsin is not so simple. False blossom has caused large losses to individuals in both States. Numerous instances of this could be cited. On the other hand, some increase in yield has been maintained in both States in spite of the inroads of the disease. It is entirely possible indeed that the efforts made to combat the disease are in a large part responsible for the increase. Once a section of bog is so injured by false blossom that it is no longer profitable it is usually reset to new vines - often of a variety more resistant to false blossom with consequent increased yields. This has been going on for at least 15 years in both States. In Massachusetts, moreover, there has been an intensive spraying and dusting campaign for the control of the insect (Ophiola striatula Fall) carrying false blossom, resulting in the development and wide use of pyrethrum mixtures which have been very successful in reducing the losses by a variety of sucking insects hitherto not controlled at all. It may well be that the final result of this control campaign has been for Massachusetts and Wisconsin a better type of cranberry culture as well as larger yield. The berries may have been produced, however, at somewhat higher cost to the grower.

Some spraying has also been done in New Jersey but apparently not enough to affect greatly the general downward trend caused by the havoc on large areas of "Native Jersey" vines. To outline fully even the obvious differences in the States which have a bearing on this marked difference in the rate of spread of false blossom would require a rather detailed review of the industry and its history in each State. The outstanding difference is probably the very much larger insect population in New Jersey.

If it be assumed, that continued increase in cranberry yields in New Jersey comparable to those in the other States would have resulted in "over-production" then the New Jersey catastrophe may be regarded as an aid to the industry as a whole and a very substantial contribution to the cranberry growers of Massachusetts and Wisconsin. It would be very difficult even in this case to argue that the assumed gain to these two States equalled the tragic loss to New Jersey. On any assumption the consumers have lost during the ten year period the use of well over three hundred thousand barrels of cranberries from the inroads of false blossom in New Jersey alone, and have probably purchased those they did consume at some increase in price per unit over what would have prevailed had New Jersey production been up to the 1921-1923 level.

## Quality of Cranberry Crop in Relation to Producer and Consumer

Quality in a cranberry crop is of importance to growers in three distinct ways, first, in its effect on the selling price of the crop or subsequent crops, and to a less extent in the loss in volume through waste and in the added cost of preparing an inferior crop for market. As regards selling price and demand the effect of poor quality is to a certain extent cumulative. Poor quality in the part of the crop first marketed often reduces the demand, even for good berries, later in the season. One crop of unusually poor quality apparently reduced demand during at least the early part of the next season.

The major factors determining "saleability" in cranberries are appearance (including color, uniformity in size and gloss) and soundness. Soundness (or keeping quality) depends within a variety chiefly on the activity of decay producing fungi and is the only one of the factors mentioned which belongs in the present discussion. Records of keeping quality for the entire period under review exist only for Massachusetts, but this State furnishes so large a part of the total crop and particularly of the early crop that it is apt to exercise a determining influence on price and on the "market."

In Figure 43 the approximate keeping quality of the Massachusetts crop is indicated by the words very good, good, fair, poor and very poor. Most conspicuous in some respects, certainly in the memory of those concerned in handling the crop, are the years 1914, 1922, 1931, and 1933, in which the Massachusetts crop was of notably poor keeping quality. In 1914, and 1933, this poor quality was associated with very large crops and with the lowest prices for cranberries in the respective periods. Under the conditions obtaining in those years the lower prices did not represent an equivalent gain to consumers for they were not low enough to compensate for the difference in quality.

The difference in price per unit as represented by the f.o.b. price per barrel between 1931 and 1932 for example was only about 15 per cent, yet the difference in keeping quality was that between one of the best and one of the poorest crops grown. In spite of all reasonable care on the part of the packers and dealers the actual percentage of spoiled berries which reached the ultimate consumer was certainly very much greater in 1931 than in 1932. The consumer then actually got more for his money at the higher 1932 price. The difference in favor of the sound 1932 berries is still further increased if one takes into consideration the extra labor involved in properly sorting a lot of cranberries which contains decayed fruit and the decidedly inferior quality of sauce or jelly if a perceptible amount of partly decayed fruit is used in its preparation.

The same is said by those then active in the work to have been true of the 1914 crop, (which for a long time stood as the worst crop in cranberry history) as compared with the much better crops of the next few years. The fate of the growers in connection with such crops as 1914, 1931, and 1933, is partly indicated by the low total received. To this must be added, however, the cost of handling and reconditioning. In such extreme cases it is too obvious to need argument "that everyone loses when fruit rots."

In 1922, it was apparently the consumer (including here the retailer) who took the larger losses, for a conspicuously poor crop was sold at an average price of $10.33, certainly giving far less value for the money than the previous crop at $13.54 per barrel. Circumstances were reversed the next year, however, when a large crop of excellent keeping quality was sold at an average price of $7.95 per barrel, a ridiculously low price necessitated in part by the fact that the trade, smarting under the experiences of 1922, was for a long time unwilling to take cranberries at any price except for immediate consumption. As a matter of fact the trade as a whole has not since returned to its former practice of buying heavily in anticipation of needs.

The influence of the less conspicuously poor crops is naturally less marked. The poor quality crop of 1919 sold for a little less per unit than the better crops of 1918 and 1920, though its much larger size raised the total income to growers almost to the 1920 level. Even in this case the difference in price to the consumer probably did not equal the difference in quality. To understand clearly the significance of this statement it is necessary to realize that the rate of decay in cranberry fruit is usually much accelerated after the fruit is cleaned and packed, both the rate of decay and the rate of acceleration after packing being greater in poor fruit than in good. It is thus frequently impossible to insure good fruit to the consumer even by extreme care when packing a lot of inferior berries.

Losses due to the poor crop of 1929 seem to have fallen chiefly on the consumer for a crop of inferior quality was sold at a unit price and total return to grower close to the maximum. There is, however, evidence that purchasers of other things than cranberries got less than adequate return for the money spent in 1929. In 1930 the price per unit fell sharply and in spite of an increase in size of crop the returns to growers also declined. The change in price was, of course, partly due to changed business conditions. Continued poor consumer buying power and very poor keeping quality resulted in selling the slightly larger crop of 1931 at the lowest price to consumers and the smallest return since the World War. On the other hand, the cost of the labor used in growing, harvesting, and packing this crop was materially less than in 1928 and 1929.

The terms indicating keeping quality of the Massachusetts crop are of course merely relative. There is always some loss from decay in the field or in storage or both. In other words, the cranberry crop is always somewhat smaller than it would be if no fruit rotted. Estimates by the most experienced observers place the average annual loss at about twenty-five per cent. In view of the facts available regarding demand and use of cranberries it seems probable that even if both field and storage rot could have been entirely prevented the total crop would apparently never have been so large as to glut the market and result in an inadequate gross return to growers. On the other hand, if we may judge from the experience of the last twenty years, the price to consumers of these hypothetical decay-free crops would have been somewhat less per unit volume than was paid for the crops actually purchased. On the whole, then, losses from fruit rots appear to have resulted in added cost to the consumer of the cranberries and certainly in no gain to producers as a group.

In attempting to set a figure for the losses to consumers of a luxury crop like cranberries one is tempted to suggest that such losses cannot be estimated in dollars but should be computed as the owner of a New Jersey champagne cellar used to figure his stock in trade, in "happy hours." But on the very conservative estimate of an average loss of 25 per cent due to decay the American consuming public has lost the use of something over 2,500,000 barrels of cranberries during the past twenty years or an average of over 120,000 barrels per year. If these could have been sold at the lowest average price ever paid for a reasonably sound crop of cranberries the American public would cheerfully have paid $15,000,000 or an average of three quarters of a million dollars annually.

Whether this may be taken as a measure of the direct monetary loss to growers depends on considerations already discussed in some detail. There seem to the writer to be good grounds for believing that it does represent a direct loss to growers for he finds little indication that the presence of these extra berries, provided they could have been sound, would have dangerously depressed the total returns to growers even in peak years. Opinions to the direct contrary have, however, been cited above. It is the general belief of dealers and sales agents that the presence on the market of fruit unattractive in appearance because of a noticeable proportion of decayed berries not only lowers prices but slows down the demand even at the reduced price. Continued observation convinces the writer that if the fruit lost by decay could have been replaced by sound fruit the resulting favorable effect on sales would have resulted in a higher actual selling price even for the increased volume.

## The Position of Groups of Growers

It must be evident from the foregoing discussion that determining the economic effects on cranberry growers, considered as a single group, of cranberry diseases and their control is a highly complicated, even controversial, matter. The special interests of the geographic groups apparently differ with the different classes of diseases and with the size of the group considered. In the case of a disease like false blossom which reduces yield, but does not injure the quality of the fruit, a high disease incidence in one section may in a given year somewhat raise the unit price of the crop and thus to this extent benefit the growers of other sections. In general this is also true of water injury and the few fungous diseases which reduce yields by affecting the plants. The absence of disease, or the use of successful control measures, is admitted by all to benefit any group of growers so long as their production is not large enough to seriously influence the size of the national crop.

The different points of view with regard to the influence of size of crop on the returns to growers as a whole have been stated at some length already. Complicated as the situation undoubtedly is when the effect on groups of growers of those diseases which cause merely a reduction in crop is considered, it becomes still more confused in the case of fruit rots which influence both the size of the crop and its quality. Serious fruit rots in one State, apparently, sometimes injure the industry as a whole. Fruit rot, of course, causes some reduction in the size of the crop but, as already noted, the most serious result is the effect on the market. This is especially true when the rot is severe in Early Blacks (the standard early variety). It is not usually possible to so pack and handle fruit containing a large percentage of rotten berries that it will stand up well or present an attractive appearance on the market. As already pointed out, the marketing season for cranberries is short and fruit from all producing sections is sold within a few months. Also the crop is not a necessity and demand depends largely on desire or inclination. The presence of inferior fruit from one section tends to depress the national market. This result occurred in 1921 as a result of very poor quality in the New Jersey berries and in 1933 as a result of very poor quality in the Early Blacks from Massachusetts. In the case of fruit rots the interests of the growers from all sections seem best served by losses in every section, so low as not to injure the national demand.

## The Position of the Individual Grower

From the point of view of the individual grower a reduction of his own crop from disease is an unqualified direct personal loss. Fruit rots result in reduction of crop, in lower price due to poor quality, in reduced demand, in the added cost of preparing the crop for market, and, in extreme cases, the losses due to reconditioning at the market.

False blossom results in reduced crops, the added cost of growing the crop necessitated by the measures to control the insect carrier, cost of rebuilding bog destroyed by disease, and capital depreciation due to loss of acreage which for one reason or another cannot be reclaimed.

The Position of the Consumer

Estimating the value of cranberries to the consumer is much like estimating the value of shade trees. The cranberry is not a prime necessity. It is obviously possible for a good American citizen to live to old age without eating cranberries or seeing cranberry sauce on his table. But it is a tasty relish, and from an esthetic point of view a very great addition to any dining table no matter how formally or informally arranged. The interests of consumers are best served by an adequate supply of high quality fruit at a moderate price. The interests of the consumer and of the individual grower appear in this respect to be identical. Both obviously gain by the most complete practicable control of disease.

## FRUIT DISEASES IN KENTUCKY

W. D. Valleau (May 19)

APPLE: In sprayed orchards scab (Venturia inaequalis) has been controlled fairly satisfactorily in spite of nearly continuous rainfall. Because of rains in the prebloom period growers expected a repetition of 1933 but scab spores did not mature until the full pink stage at which time growers had already applied two sprays. In the station orchard leaf infection is almost entirely absent at present.

Blight (Bacillus amylovorus) on twigs has developed in several places in western Kentucky and in Fayette and Mercer counties in the last few days. The disease has been nearly absent for several years. Continuous rains probably a factor.

PEACH: Blossom blight and twig cankers caused by the brown rot fungus (Sclerotinia fructicola) have been reported from Henderson and Hopkins counties and some twig cankers found in Fayette county. Almost continuous rain has afforded excellent conditions for brown rot. There have been 8.3 inches excess rain since January 1.

RASPBERRY: Cane blight (Coniothyrium fuckelii) appears to be the most destructive disease of black raspberry in Kentucky as the disease continues throughout the winter killing back the lateral shoots several feet. Infection appears to occur in heavy wind and rain storms in late summer. Several commercial plantings in the Parksville district have been unprofitable because of this disease.

Winter kill. There was considerable contrast between rows of Latham raspberry sprayed in 1934 and unsprayed rows this spring. Winter killing was greater in unsprayed rows, but was not nearly so severe as the previous year. Five sprays did not control leaf spot of Chief sufficiently to prevent considerable weakening of fruit spur buds.

## FRUIT DISEASES IN TENNESSEE

E. M. Prather (May 24)

APPLE: Due to prolonged rainy periods and cool weather previous to, during, and after the blooming period of the apple, we have a heavier infestation of cedar rust (Gymnosporangium juniperi-virginianae) in most parts of the State than we have had for several seasons. I have found quince rust (G. clavipes) in Davidson, Jefferson, and Madison counties to date. I will not be surprised to find it generally distributed throughout the State. This is the first year that I have found cedar rust on the stems of Golden Delicious apples. It is commonly found on the foliage of this variety from light to severe infections.

Frog-eye (Physalospora obtusa) made its appearance early in the season. It was showing in one Davidson County orchard at the blooming period. A Rhea County orchard of Red June carried such a heavy infection by April 24 as to cause defoliation to begin. Many mummied apples were still present in the orchard and, although sprays had been applied in the calyx and first cover periods, they had little effect on controlling the infection in the presence of the mummied fruit.

Apple scab (Venturia inaequalis) is not troublesome in orchards that have been sprayed according to our schedules. The infections to date are light. Unsprayed orchards have a moderate to heavy infection.

Blight (Bacillus amylovorus) in orchards not receiving full bloom sprays of 1-3-50 Bordeaux mixture has caused considerable damage to susceptible varieties. Those orchards that were carefully sprayed have less than a 5 per cent infection. Transparents sprayed twice in bloom, the first application applied when 50 per cent or less of the blossoms were opened and the second when the remainder of the buds had opened escaped the fire blight or blossom blight remarkably well. Scattering infections of new terminal growth was to be noticed in one such orchard on May 18. Pear trees throughout the State have been severely injured by this disease.

The full bloom applications of Bordeaux mixture have had considerable value in scab control and frog-eye or black-rot disease. From observations made in the field during the past three years, it would

seem that spraying in full bloom is proving to be one of the most valuable early season sprays, especially when applied to those varieties which are susceptible to scab and fire blight.

PEACH: A light infection of brown-rot blossom blight (Sclerotinia fructicola) was to be found throughout the eastern Tennessee commercial peach district. The infection was not severe enough to affect the crop materially in any orchard observed. However, the infection from the blossom carried into the bark tissues and there formed cankers which frequently girdled the twig and caused death to all portions of the twig above the canker. Properly sprayed orchards will have little to fear from this early infection.

Observations made on the Red Bird variety in two local market orchards indicate that this variety is more susceptible to the brown-rot blossom blight than is Elberta. Ninety per cent of the blossoms were infected in these two orchards. These observations agree with those made in previous seasons.

## OBSERVATIONS ON FRUIT DISEASES IN ILLINOIS APRIL AND MAY 1935

H. W. Anderson

PEACH: Leaf curl (Exoascus deformans) is extremely abundant throughout the State. It appeared in the extreme southern section as early as April 1 and extended north as the peach leaves developed. It is probably the most severe outbreak in the past twenty years with the possible exception of 1933. Oil Bordeaux dormant sprays (8-8-100) gave perfect control when applied either in the late fall or early spring. Some growers who waited too long in the spring failed to get control.

Observations this year again emphasize the relation of the spray schedule of the previous summer to control the leaf curl. Very few orchards had a crop in 1934 and consequently were not sprayed for brown rot control. In some orchards with a crop the regular sulfur sprays were applied and although no dormant sprays were applied to some of these orchards very little leaf curl developed. It was noticed, however, that more leaf curl developed in these orchards than in those where a dormant spray (with or without brown rot summer sprays) was applied. Thus it may be concluded that summer spraying aids in the control of leaf curl the following year but should not be depended upon for complete control.

One grower who secured control made application of liquid lime sulfur 1-12 on March 6 and 7 when the first pink was showing in the flower bud and the tips of the leaves were beginning to push out of the leaf buds. He secured 100 per cent control although a part of the orchard had not had a previous summer application. About a mile away

another grower sprayed on March 11 and 12. He had a general, heavy leaf curl infection. The first grower, of course, sprayed later than we recommend but this season the moderately late sprays seemed to give good control.

A 6-6-100 oil Bordeaux gave satisfactory control in one experimental orchard where a 4-4-100 gave only moderate control.

The weather this spring has been ideal for the development of peach leaf curl. The buds opened fairly early and during the entire blooming period cool rainy weather prevailed. In some sections peaches were in bloom over a period of two weeks.

Due to the excessive rains during the blooming period more than the usual amount of brown rot twig blight (Sclerotinia fructicola) developed. Cankers were usually formed at the base of old leaf or fruit scars rather than around blossoms. For this reason it is thought that blossom blight played a minor part in the development of twig blight this season.

Winter injury and freezing. In the extreme southern section of the State low temperatures on January 23 and 24 caused some injury. The killing was local in that within a few miles extreme variations in temperature occurred. Although temperatures were slightly lower in the south central and central sections of the State little injury occurred.

Low spring temperatures caused some injury in the east part of the south central section. The thermometer registered 27° at several points in the Olney peach area on April 15. At this time the petals had fallen but the shucks were still on the fruit. The damage was most severe on young trees and was local.

APPLES: (May 15) Ideal weather for apple scab infection occurred in all sections of the State from the breaking of the buds to the present. In general the amount of scab that developed was correlated with the drought conditions of 1934. All sections of the State suffered from drought but the section between the Illinois and Mississippi Rivers in western Illinois had no rains during the entire spring and summer. Southern Illinois had fairly good rains early in the summer and again in August.

In spite of heavy and continuous rains and cool weather very little scab is to be found on the apple foliage in western Illinois. In the southern and south central section scab is appearing in some orchards and is very severe in a few. In the central section (Urbana region) it has been hard to find scab.

An examination of the old leaves this Spring was made in the Urbana region and in the southern end of the State. It was very hard to find any perithecia. Mature ascospores were found in early April at Urbana, but it is probable that they could have been found at a much earlier date. The first scab was observed on check plots in southern Illinois on April 15.

(May 22) Apple scab is appearing in a severe form on this date in southern Illinois on fruit. The first lesions did not appear until May 18-19, although it has been quite common on the leaves since April 15. It is also appearing on leaves in western Illinois where no scab could be found on May 8-10. This late appearance of scab in western Illinois is evidently associated with a very light primary infection which has been built up by continuous cold rainy weather into a general secondary leaf infection which now threatens the fruit. The lack of control is due in a large measure to the washing off of the sprays applied and the inability of the growers to keep the trees covered;

Blossom and twig blight of apples (Bacillus amylovorus) was observed near Salem, Illinois, on May 13. Pears in this region showed no evidence of twig blight.

A recent trip through southern Illinois showed that fire blight on pear was appearing and was quite general on May 20-21. Also some late infection on apples, especially Jonathan, in scattered orchards. It is quite local on apples to date.

BLACKBERRY: Orange rust (Gymnoconia peckiana) is general on wild plants throughout the southern end of the State.

## FACTORS RESPONSIBLE FOR THE SMALL STRAWBERRY CROP IN LOUISIANA THIS YEAR

A. G. Plakidas (May 27)

The production, per acre, of the 1935 strawberry crop in Louisiana was one of the lowest, if not the lowest, in the history of the strawberry growing industry of the State. The yield per acre was 43 crates[1] which is considerably lower than even that of the disastrous year, 1927. The chief factors responsible for the crop failure were the freeze injury and the Sclerotinia crown rot disease.

Freeze Injury: Very mild weather prevailed during the last three weeks in December and the first three weeks in January. During this period of mild weather, the plants were making very active growth, and, by the middle of January, were blooming profusely. This mild weather was followed by a very severe cold wave that lasted from January 21

[1] This figure is based on an estimated acreage of 29,000 acres, 1797 carloads shipped, and an average of 700 crates per carload.

to 23, with a sudden drop of temperature from about 70° to a minimum of 14°F. in the strawberry growing section. The cold killed not only all the unfolded blossoms, but also many of the young ones still within the crown. Furthermore, the vegetative parts of the plants were affected. Practically all of the outer leaves were killed (except in some few sheltered fields or where the plants were covered with mulch), and some of the plants (between 1 and 3 per cent) were killed completely. This cold spell was followed by a 33-day period of mild weather during which the plants again blossomed profusely. The second output of blossoms was killed completely by the second severe cold wave from February 26 to March 1. Some of the growers estimated that the two cold waves caused at least 50 per cent damage to the crop. This estimate, while probably correct for some of the fields unprotected by wind-breaks, is not correct for the entire strawberry-growing section; a closer estimate, in my opinion, is between 25 and 30 per cent for the entire area.

Sclerotinia Crown Rot: Crown rot caused by Sclerotinia sclerotiorum occurs on strawberries in Louisiana every year, but the losses from this disease are usually very small. In certain years when weather conditions favor its development this disease may become very destructive. This was the case in 1927 and again this year. Weather conditions were especially favorable for its development this year. It rained practically daily from the ninth to the sixteenth of February, and again from the fourth to the ninth and also on the twelfth of March. During these long wet spells, cool temperatures prevailed and the atmosphere was saturated with moisture, conditions which especially favor the growth of the causative fungus. Then, too, the plants were weakened by the freeze injury and were probably more susceptible to infection than they would be normally. The freeze-killed leaves collapsed around the crown and came into close contact with the soil. In many cases, the fungus started its growth on the dead and injured leaves and from there spread to the crowns. Counts of affected plants were made at different intervals from February 15 to the middle of April, and it was found that the percentage of affected plants varied in different fields, or in different parts of the same field, from 6 to 25. It is a conservative estimate to state that, for the entire strawberry growing area, an average of 15 per cent of the plants was affected. All the attacked plants were not killed, but all were rendered worthless as far as fruit production was concerned. So this disease may be considered as one of the chief causes (second in importance only to the cold damage) for the exceptionally small strawberry crop in Louisiana this year.

Other Diseases: Leaf spot (Mycosphaerella fragariae) and scorch (Diplocarpon earliana) caused less damage this year than usual. This was due (1) to the fact that spraying for the control of these diseases has become almost a universal practice, and (2) to the dry weather prevailing during the fall. Only 1.61 inches of rain fell in the Hammond area in September. No rain fell from the thirtieth of September to the

nineteenth of November, with the exception of .02 of an inch on the twenty-fifth of October, and .75 of an inch on the third of November. This drouth helped to check the spread of the leaf blights and so the fall planting was done with unusually clean plants.

The losses from rots of berries in the fields were very small this year, and this was due, no doubt, to the relatively dry and cool weather prevailing during the picking season. Of the different berry-rotting organisms, Botrytis was the most common.

## STRAWBERRY DISEASES IN ARKANSAS

V. H. Young

There are unusually large amounts of disease in the strawberry fields this year. I think we are having more trouble than since 1927. The common fruit rots are very prevalent. The "suspected mosaic" (leaf variegation) of Blakemores is very pronounced in the fields visited, and it will certainly be a serious problem with us. There was also a great deal of damage from the common leaf spot (Mycosphaerella fragariae) and from leaf scorch (Diplocarpon earliana). Leaf injury was pronounced and there was a great deal of injury to fruit stems resulting in failure of the fruit to develop and mature properly.

Due to the drouth of last year the stand was very poor everywhere in the State.

## CEREAL DISEASES IN KENTUCKY AND TENNESSEE

MALNUTRITION AND LEAF RUST OF WHEAT IN KENTUCKY: Specimens of wheat making poor growth, light in color, and heavily rusted have been received from Marion county. Almost continuous rains have probably reduced nitrification to a minimum in heavy, poor soils resulting in starvation of the developing wheat.

Wheat is not yet heading in Fayette county but is already heavily infected with leaf rust (Puccinia rubigo-vera tritici = P. triticina). (W. D. Valleau, May 19)

DISEASES OF RYE AND BARLEY IN TENNESSEE: Stem smut, Urocystis occulta, was found on 5 per cent of a ten-acre field of rye in Anderson county.

A 25-acre field of barley in eastern Tennessee showed 100 per cent infection with powdery mildew, Erysiphe graminis. An intensive and extensive survey has been made to estimate the amount of loss caused by the barley smuts. One county in eastern Tennessee was selected for the intensive survey. The percentage loss was arrived at by making a minimum of ten counts of 100 consecutive plants each, selected at random, in 27 fields comprising 350 acres. The loss in these fields varied from 5 per cent to 45 per cent, with an average loss of 18.5 per cent. The loss sustained in this county was apparently representative of the loss in all of eastern Tennessee, as evidenced by less intensive observations in 8 other counties. It was impossible always to distinguish the loose from the covered smut, but there appeared to be about five times as much covered smut (Ustilago hordei) as loose smut (U. nuda). (Paul R. Miller, May 29)

## CURRENT NOTES ON PLANT DISEASES

SWEET POTATO STEM ROT IN MISSOURI: At Springfield, Missouri, the Nancy Hall sweet potato slips of one grower showed about 50 per cent infection of Corticium vagum. Only a very slight infection was observed in the Porto Rico variety. The infection apparently originated in the soil used for bedding. No other similar infection of this organism has been observed. (J. C. Dawson, May 27)

TOBACCO WILDFIRE IN KENTUCKY: Specimens of tobacco affected with wildfire (Bacterium tabacum) have been received from Graves, Calloway, Trigg, Lyon, and Todd counties in the Dark tobacco section. Previously it has been reported only from Graves and Calloway counties in west Kentucky. (W. D. Valleau, May 19)

MAPLE LEAF SPOT IN KENTUCKY: White, red, and hard maples have developed severe cases of anthracnose in some parts of central Kentucky evidently due to species of Gloeosporium. Reports state that individual trees or individual branches are severely affected and others not. (W. D. Valleau, May 19)

MAPLE LEAF BLIGHT IN ARKANSAS AND TENNESSEE: V. H. Young writes that the fungus causing a leaf blight of Acer saccharum was determined by J. J. Davis as Tapharina, probably T. polyspora (Schok.) Johans., nearer to the variety pseudoplatani Massal. than to the type.

According to Paul R. Miller many cases of severe infection of maple with Tapharina sp. have been observed and reported in eastern and middle Tennessee this season.

SYCAMORE ANTHRACNOSE: The anthracnose of sycamore (Gnomonia veneta) is usually prevalent in the District of Columbia and vicinity this year.

PEONY ANTHRACNOSE: Peony anthracnose caused by Gloeosporium cingulatum is not common, according to Philip Brierley of the Division of Fruit and Vegetable Crops and Diseases. Recently he received specimens of peony stems and buds affected by this disease from a grower at Hickory, North Carolina.

BROWN ROT DIE-BACK OF FLOWERING ALMOND IN KENTUCKY: A die-back of flowering almond due to the brown rot fungus (Sclerotinia fructicola) has been observed (W. D. Valleau, May 19).

## ANGUILLULINA DIPSACI IN IMPORTED GALTONIA CANDICANS

R. J. Hastings

Through the courtesy of the Plant Quarantine Office, Court House, Vancouver, British Columbia, a number of bulbs of Galtonia Candicans, summer-hyacinth, affected by Anguillulina dipsaci (Kuhn) Goodey, the bulb nematode, were received. These bulbs were part of a shipment of three hundred and fifty from Holland, intercepted at the Plant Quarantine Office, Vancouver.

The bulbs were in varying stages of decay hastened by saprophytic nematodes and bacteria, and gave off an offensive odor. In some cases the nematode infestation appeared to have originated in the outer scale and had penetrated five scales causing a small brown decayed area in each, with the outer scale almost completely rotted over half the circumference. In other cases, the outer scale was decayed, and the next two or three unaffected with an infested scale inside presenting the brown ring similar to nematode infestation of narcissus bulbs.

Galtonia candicans is listed as a host of A. dipsaci by Steiner and Buhrer (Plant Dis. Reptr. 16: 76-85, 1932), but apparently no previous interceptions of Galtonia infested by A. dipsaci from abroad have been recorded. So far as known, no reports of infestation in American grown bulbs have been made. (Laboratory of Plant Pathology, Saanichton, B. C.)